THE BATTLE-SHIP OF THE FUTURE—A REPLY TO ADMIRAL COLOMB.

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A BATTLE-SHIP is that fighting ship which combines in the highest possible degree the powers of offence and defence. This is no new distinction, for in all times the ships which possessed these high qualities, whether propelled by oars, sails, or machinery, have been accorded the honor of bearing the shock of battle when fleets have met. Other vessels intended for special purposes have been always associated with the battle-ships. Never in the history of navies have these auxiliaries been so numerous in proportion to the number of battle-ships, or so various in type, as they are now. We have cruisers large and small, protected cruisers, armored cruisers, rams, commerce-destroyers, gunboats, torpedo cruisers, torpedo boats, etc. Each of these types has its own characteristics, in which speed, the number and size of guns, coal endurance, manœuvring power, etc., are made most prominent, according to the supposed needs of the case. Each is a fighting ship in its way; but none of them, nor all of them acting together, could be expected to meet a battle-ship in a fair fight. Before a fleet of battle-ships a host of these other craft must scurry to cover, or only venture out under protection of darkness.

Attempts are periodically made to magnify the importance of each of these types of auxiliaries. At one time we are told that a fleet of commerce-destroyers would constitute the most efficient naval force for a nation; again, it is a fleet of rams or a sufficient number of torpedo boats. While commerce-destroyers might succeed in driving an enemy's commerce from the seas, Mahan

has shown that this alone is not sufficient to terminate a war, or even to greatly influence the result. A fleet of swift and heavy rams would be able to greatly annoy a smaller number of battle-ships, but they could do little more. Nor could those night-hawks, the torpedo boats, hope to do more than frighten their big enemies, the battle-ships.

It is not intended to assert that rams or torpedo boats could not occasionally destroy a battle-ship, but the circumstances must be very favorable to the smaller craft to admit of such a result. It is not intended in this brief article to attempt to give the reasons for these opinions. They are expressed here only to define and outline by contrast the characteristics of the battle-ship, which embodies in the highest degree in which they can be combined the good qualities of all other fighting ships. She mounts heavy guns to pierce the armor of her enemies; she mounts numerous guns of lighter calibre to enable her to meet similar fire from all sorts of craft and to destroy the quick-moving torpedo boats which would escape the slow-working, heavy guns; she carries armor to protect herself against any but the heaviest projectiles, and, so far as possible, against even these; she carries torpedoes to destroy an enemy who may, in the manœuvres of battle, come within her reach; she carries such a supply of coal and ammunition as will enable her to perform her duty between the times when she can renew her supply. Being essentially a fighting machine, she does not require high speed to enable her to escape from an enemy. When war shall come between any of the great nations which depend in whole or in part upon their naval strength, it will be the battle-ship which will settle the issue. And such, in brief, is the battle-ship of to-day.

But the battle-ship of the future—to predict her design would be to solve at once problems destined for many a year to baffle the skill of the naval architect. If the powder question were settled forever, if the quality of gun steel and the system of manufacture of guns were decided beyond cavil, if the quality of armor had been definitely established, if the strength of projectiles had reached a limit, if the means of attack and defence were to be restricted to those now in use; even were all these elements fixed and unalterable, yet would it be a difficult task to predict the design of the future battle-ship. But, when it is re-

membered that these elements may alter, that they may be modified, that they may even be exchanged for others more suitable, the problem becomes more complex, the solution more difficult. When it is also borne in mind that many other elements of design which are not purely military are likewise liable to change, such as the character of the fuel used, or the whole system of propulsion, the prediction partakes of the nature of prophecy.

A brief glance at the influence which would probably be produced upon the future battle-ship by a modification of each of the elements referred to may assist us in arriving at a conclusion as to the probable influence of all combined. If, at the same time, we glance at the progress or changes which each has undergone during thirty years, which comprehend the period in which the greatest changes have been made, we shall have the important aid of history also to guide us.

We may, for brevity, consider together the gun, its powder and projectile, for, as Admiral Colomb has said, the gun will probably always have a predominating influence in deciding the design of the fighting ship. That battle-ship will best fulfil its mission which carries the most powerful battery the most steadily, with the greatest celerity, from place to place, and to the greatest distance, and in which the stability is best protected.

The power of the gun has enormously increased within the past thirty years. This increase in power is not represented by increase in size, but by the greatly increased velocity which it imparts to a projectile greatly increased in weight. The 15-inch smooth bore guns mounted in our monitors, which may be taken to represent the maximum efficiency of guns in our service thirty years ago, would barely penetrate six inches of iron at the muzzle, while at 1,500 yards the penetration would not exceed 3½ inches. The 13-inch rifles to be placed in our battle-ships will penetrate 27 inches of steel at the muzzle, or 23 inches at 1,500 yards; at greater distances the difference becomes more marked.

Smokeless powder, whose greatest advantage lies in the high velocity it can impart to the projectile, will probably still further increase the velocity as the powder is developed. This may, and probably will, continue until it becomes necessary to modify the form of the gun and increase the strength of the material. As the slow burning brown powder was a step in advance of the quicker burning black, distributing the pressure more uni-

formly along the bore of the gun, so does the smokeless powder make a decided advance in the same manner, until we now have reached a muzzle velocity which is nearly double what was obtained with the smooth bore thirty years ago, and which, at a distance of 1,500 yards is three times as great as was possible with the old gun. We may expect the mutual reaction of the gun and the powder, as regards development, to continue. Every improvement in the powder will be met by an appropriate modification in the gun, and every increase in the strength of the gun will be utilized by an increase in the pressure of the powder. Thus the energy of the projectile will increase and the difficulty in controlling the recoil of the gun will become greater. When the energy of the projectile was but a few hundred foot tons, it was comparatively easy to restrain the recoil, but when the energy of the projectile rises to 30,000 foot tons, it becomes a far more difficult problem to control the recoil, demanding the use of powerful hydraulic machinery. The necessary protection of this machinery has led to an increase of armor on the ship beyond what was before necessary, and this in turn has demanded a larger ship to carry it.

The increased velocity has made necessary greater strength in the projectile, for those of cast iron are broken to fragments, even against light and soft armor; wrought-iron projectiles are deformed like a leaden bullet ; cast steel is only better than cast iron, but the very highest skill of the metallurgical art has succeeded in producing an armor piercing projectile of wonderful strength, which, under favorable conditions of impact, can transfer nearly its total energy to the opposing armor. Yet in this very matter of projectiles naval artillery is now the weakest. The energy which the gun can impart to the projectile is sufficient to crush the strongest to fragments, even when the armor is soft, if the line of impact is oblique to the armor ; and when the armor is hardened by the Harvey process the projectile is nearly always broken, whatever may be the line of impact. The armor-piercing power of the gun is therefore limited by the strength of the projectile which can be manufactured.

Turning for a moment to the armor itself, we see that since the time when wooden walls were found to be insufficient protection against the increasing energy of the shot, and the introduction of steam engines made more effective protection necessary to

save the machinery from injury, it has been one prolonged struggle for supremacy between the gun and the armor. For every increase in the power of the gun there was an increase in the thickness of the armor, until the armor became so heavy that its protection had to be limited to a portion of the ship and even then only large ships could carry the weight which was required. Then commenced a decided improvement in the quality of the armor, which has progressed through the vicissitudes of compound armor and all steel armor, and has now developed into alloys of nickel and steel, of chrome, nickel, and steel, and has finally culminated in the Harvey process of hardening the surface of the armor made of the above alloys. This armor, as before stated, defies the best projectile which has yet been produced. The armor has now decidedly the advantage.

It has reached such a stage of development, has attained such a degree of excellence, that it may in future be reduced in thickness 25 per cent. under what was but just now considered necessary. This weight may be saved or expended to increase the protection, the battery power, the speed or the coal endurance. If saved, we shall have a smaller ship, retaining all other characteristics of battery, speed and endurance, but manifestly in no great degree superior to the larger ship carrying thicker armor. Each would have the same protection, battery, speed and endurance. The smaller ship would be considerably less in cost and more economical in maintenance. On the other hand, the saving in weight due to the superior quality of armor may be used to increase the area of the armor, and there will result a ship having all the characteristics of the original, but with better protection.

If additional protection is not considered as desirable as additional power of offence, then the additional weight can be used to increase the number of guns or increase their size. The choice between increase in size or increase of numbers would depend upon whether or not the guns are already large enough for the purpose intended. It would be folly to arm a ship with guns manifestly overmatched by the armor of her enemy. On the other hand, guns which are too large are correspondingly less efficient.

To apply the saving in weight to an increase in speed beyond the present limit of about fifteen to seventeen knots is not per-

missible, nor is it desirable to increase the coal endurance beyond what is necessary to enable the ship to reach and act at the points intended.

To go somewhat more into detail, we see that the design of the fighting ship, in distinction from that of a cruiser, must depend upon the guns which she is to carry. From this single condition, when rightly interpreted and understood, will follow all other requirements. For instance, the guns must have power to overcome the armor of her adversary. Should the adversary make the mistake of encasing herself in such thick armor that she must limit that armor to a comparatively small area, leaving sufficient unprotected to render her a certain prey to moderate guns, then it would not be necessary to attack her armor in order to destroy her. The armor protection then should be so distributed that it must be punctured to fatally injure the ship. It may be stated as a rule that the battle-ship should carry guns that will overmatch, at least under favorable conditions of impact, the armor which she herself carries. This may seem to be reducing all fighting ships to the same level, leaving no advantage with either of two opposing sides. But it must be remembered that, like two opposing armies, the victory will probably rest with the one which can bring the greater number into action.

The oft-repeated proposition to save weight in armor by reducing the freeboard, or, in other words, by making the fighting ship of the monitor type, will not produce the ship of the future. Those who advocate the monitor overlook the fact that the present battle-ship has incorporated the only useful feature of that type, which is the turret. The low freeboard of the monitor is not compatible with the present speed. Considerable height is necessary to keep the bow wave from coming on board the ship. No better illustration of this can be found than in our coast defence vessel, the "Monterey." At her maximum speed of about fourteen knots, the forward part of the vessel is several feet under water, rendering it impossible to make good practice with her forward guns, when running even at less than maximum speed.

Bearing in mind that the following remarks are limited to the battle-ship and recalling her description, we may venture to predict the directions in which this mighty engine of war will be developed,

First, It may be stated with confidence that her speed will be quite moderate, not exceeding sixteen or seventeen knots, as a maximum. Undoubtedly there might arise occasions when a higher speed would be of advantage to a fleet in pursuit of a weaker one, or when it would prove invaluable to the weaker one in making her escape ; but these occasions are strategical and not tactical. That is to say, small difference of speed will cut no figure in an actual engagement, nor will superior speed enable the defeated fleet to escape ; for it will be found now, as in the time of sailing fleets, that, after a general engagement, the victors will have the advantage in speed even if they did not before. It will be one of the surest signs of defeat that the vanquished have lost in manœuvring power. The fleet having the highest average speed will have it in its power to avoid an engagement, but it cannot be said with certainty that an advantage in speed will enable a fleet to bring on an engagement. Now, when it is remembered that an increase in speed demands the sacrifice of other qualities which are of vital importance in a fight, I think the limit fixed will prove a safe prediction.

While high speed in a battle-ship is not demanded, economical speed is a very important consideration. It is important that the maximum speed may be depended upon at all times; hence the importance given to the question of sheathing and coppering the bottoms of steel ships to prevent the marine growth and consequent loss of speed. Without going into the merits of sheathing, it is thought that the time is not far distant when some more efficacious method will be found for preventing this marine growth. The advocates of sheathing overlook the fact that it is at best only a partial remedy. The injurious effect of foul bottoms has been brought into prominence by the high speed of recent years. When wooden ships were sheathed and the speed was low, the loss from this cause was far less noticeable, although bottoms were foul.

Second, The coal endurance of the future battle-ship must be determined by the distance at which she may be required to act from her base of supplies. This, in its turn, must be determined by the policy of the nation. Our own country having no distant colonies to defend will maintain but a moderate fleet of battle-ships and only for defensive purposes. A proper defence, however, demands that an enemy shall not be permitted to establish

or maintain a base of supplies on our side of either great ocean. This consideration limits the necessary endurance of our battle-ships to a very moderate amount, but to cover all probable demands it should be fixed at about 5,000 miles at an economical speed. All the reasons for this estimate cannot be stated here.

With the introduction of liquid fuel, this endurance might be reduced. Objections still exist to the use of this fuel, but so desirable is it for naval use that we may count upon the removal of them. The fact that its advantages are not so great for the merchant service has delayed its adoption, and will continue to do so for a time. As soon as a demand for it is created it will be manufactured in necessary quantities. We shall then see our ships receiving their fuel in a few hours instead of requiring days, as is now the case. Subdivision, one of the greatest safeguards against under-water injury, may then be greatly extended.

It is evident that moderate speed and moderate endurance will in themselves require a ship of but moderate displacement. It remains to be seen how other requirements will influence the size of the ship.

Third, The subjects armor and armament are best treated together because they are so interdependent. It has been stated, probably without much consideration, that armor will be abandoned for the same reason that led to its abandonment as a personal protection for the soldier, because it had ceased to protect against the improved weapons of warfare, and the weight of the armor could not be increased. But this condition of things does not seem likely to arise in regard to ships. Aside from this, the armor carried by fighting ships is principally for the protection of the stability and machinery of the ship, rather than the men who man her. If any one is in doubt as to the utility of armor on a battle-ship, let him consider from every imaginable point of view the result of an engagement between two fighting ships of the same displacement, one protected by suitable armor and the other without it. The unarmored ship has the advantage that she can devote the weight given to armor in her adversary to increasing the weight of her armament, increasing her speed, or increasing her endurance. Each of these would be an undoubted advantage, but when we consider these advantages as they bear upon the supreme moment when the ships are engaged in battle, we see that the question of coal endurance is not likely to influ-

ence the result; for it will depend quite as much upon which has received the most recent supply as upon the actual quantity each can carry in her bunkers.

The advantage of superior speed in battle will consist mainly in ramming and avoiding the ram; but it seems very improbable that an unarmored ship would venture to ram an armored one; if this view be correct, the advantage in superior speed will be limited to that of enabling the unarmored ship to choose her fighting distance. As a very moderate superiority of speed would enable her to do this, it would be best to use a large part of her extra displacement in increasing both the weight of her guns and their number. She would thus, by the superior volume of her fire, have some compensation for her own vulnerability. But whatever increase of weight she could possibly give to her guns would be far more than compensated for by the resistance of the armor of her adversary. The unarmored ship would appear to be left with the overwhelming disadvantage that every blow she received would pierce her through and through. Under such circumstances all her other advantages would disappear. Neither superior speed, endurance nor armament could compensate for lack of protection.

The armor applied to a ship has two distinct objects—first, to protect the stability of the ship, and, second, to protect the machinery contained in the ship; included in the latter is not only the propelling machinery, but more especially, from their otherwise exposed position, the guns and the machinery necessary for working them. Incidentally the armor which protects the guns protects the men stationed at them. The larger the guns, the more extended the appliances for handling them, and, consequently, the more effective the protection required. In other words, where heavy guns are mounted, heavy armor must be used, and both conspire to increase the size of the ship.

The necessity for armor being admitted, it remains to determine where its utility ceases. This brings us face to face with the controversy of small ironclads *versus* large ones. Those who advocate the smaller vessels do so on the ground of economy and in the belief that a number of small vessels, costing less than the price of one battle-ship, would be more than a match for her in battle. A little consideration will, I think, show the fallacy of this contention, for if we assume the same characteristics for both

the battle-ship and the smaller ironclads, it can be shown that they can be more economically obtained in one structure than when distributed among several. If it is assumed that a number of smaller vessels, with less gun power than the battle-ships, can vanquish her by mere force of numbers, there is no good ground for the assumption. The smaller vessels must collectively be at least equal in this respect to their larger antagonist; they must, also, have equal protection, or they will be at a decided disadvantage. In the days of sailing ships, when the manœuvring power was very restricted and guns were necessarily mounted in broadside, it was possible for a number of small vessels to take such positions with reference to a larger antagonist as to put her quite at their mercy. This is not now the case. A battle-ship, with her battery rightly disposed, would be quite indifferent as to the position assumed by such enemies. On the other hand, in the case under consideration, the smaller vessels would be obliged to take position on the beam of the battle-ship if they hoped to pierce her armor, or they must rely upon destroying her by an attack upon her unarmored parts. Without mentioning the greater steadiness of the battle-ship, it may then be fairly assumed that she would be more than a match for the smaller ironclads, whether cost or gun power be made the basis of comparison.

Where then shall cease the constant tendency to greater size which accompanies increase of gun powder and armor protection? If a large vessel is better than a smaller one, can there be any limit? Several considerations control the dimensions. The great cost is a most potent one. A first class battle-ship costs $5,000,000, and only a first class nation can afford to maintain a fleet of such costly weapons. Certain numbers are required in order that their services may extend over a greater area and consequently the individual size or cost must be limited. The liability to accident increases with the dimensions; in taking the ground, or in collision, the great weight of the battle-ship is her destruction. For our own country a decided limit is fixed by the depth of water in our harbors,—for, manifestly, our battle-ships should be capable of entering our own ports. Doubtless the limit has been reached in the "Iowa," now building. Nor need we fear that our battle-ships of 10,000 or 11,000 tons will be greatly outclassed by anything they will ever encounter.

The battle-ship is, or should be, at every stage of the develop-

ment of the art of naval warfare, a definite machine; and only such variations from a fixed character should exist as are demanded by her environment; by which is meant the character and extent of the area over which she is intended to act. A battle-ship is intended to meet the enemy and fight to a finish. Numbers will, of course, in most cases determine the result, but this is no argument against the theory that the individual ships should possess in the highest degree attainable the maximum fighting power. And very important it is that the battle-ships of a nation should possess uniformity in speed and manœuvring power. That nation which possesses the most homogeneous line of battle has, other things being equal, a great advantage. So important is this consideration that it would be better to sacrifice some qualities which would be a decided improvement in a new ship rather than depart from the leading characteristics of the other ships with which she must be associated. It is not intended by this to exclude improvements, but they must be important ones to outweigh the advantages of a homogeneous fleet.

In conclusion, I may say that the battle-ship of the future will, like all human contrivances, be of gradual growth, resulting from the adaptation to her use of improvements and discoveries in many branches of science. Under the crucial test of war it may be found that many mistakes have been made. If I should venture to point out one of these, it would be the multiplicity of devices which every branch of physical science has contributed to overcrowd our ships. Not that they do not admirably serve their purpose, but I fear that we, as sailors, are growing to rely upon them, and will be lost when the rude shock of battle breaks our electric wires and disarranges the delicate machinery upon which we now depend in a thousand ways. In the main, however, I venture to think that the battle-ship of to-day has a sound reason for all her principal features, and the type will persist. The stability will continue to be carefully protected by vertical armor. Many of the accidents both in battle and times of peace, to which great ships are liable, will be diminished by the adoption of liquid fuel. The main battery will be mounted in turrets furnishing complete protection to the guns, and, as far as possible, to the machinery for their manipulation, and for the supply of ammunition. The secondary battery will be protected in proportion to its importance, while every gun

position with its crew will be protected against machine and rapid gun fire. The time will never come when we shall cease to demand higher requirements in the battle-ship. Fortunately all requirements are interchangeable. Armor may be substituted for guns, guns for fuel, so that the saving in one direction may at once be utilized in another. The advent of hard-surfaced armor will demand that the calibre of the main battery be maintained; for until projectiles of greater strength can be produced the only way to overcome Harvey armor is to crush it with an overwhelming blow. In addition to this, it will undoubtedly be found that all armor under the constantly varying angles of impact in battle will furnish greater protection than is considered possible when judged by the result of normal impact on the proving ground. For this reason again, the larger calibre of the gun must be maintained, and this, in its turn, determines the great size of the battle-ship of the future, subject to the restrictions which have been indicated.

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